

Oral Exercises

Express each logarithm in terms of $\log_3 M$ and $\log_3 N$.

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|--------------------------------------|----------------------|---------------------------|--|
| 1. $\log_3 M^4$ | 2. $\log_3 N^6$ | 3. $\log_3 M^4 N$ | 4. $\log_3 \left(\frac{M}{N^3}\right)$ |
| 5. $\log_3 \left(\frac{1}{M}\right)$ | 6. $\log_3 \sqrt{M}$ | 7. $\log_3 \sqrt[3]{N^2}$ | 8. $\log_3 \left(\frac{1}{N\sqrt{N}}\right)$ |

Express as a logarithm of a single number or expression.

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| 9. $\log_a 3 + \log_a 4$ | 10. $\log_a 7 - \log_a 5$ |
| 11. $4 \log_a 2$ | 12. $2 \log_a 9$ |
| 13. $\frac{1}{2} \log_a 36$ | 14. $-\log_a \frac{1}{6}$ |
| 15. $\log_b 3 + \log_b 5 + \log_b 2$ | 16. $\log_b 6 + \log_b 5 - \log_b 2$ |
| 17. $2 \log_b p + \log_b q$ | 18. $\log_b x - 3 \log_b y$ |
| 19. $\frac{1}{2} \log_b r + \frac{1}{2} \log_b s$ | 20. $\frac{1}{2}(\log_b x - \log_b y)$ |

Written Exercises

Express each logarithm in terms of $\log_2 M$ and $\log_2 N$.

- A**
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|-----------------------------|--|----------------------------------|-----------------------------|
| 1. $\log_2 M^6 N^3$ | 2. $\log_2 (MN)^4$ | 3. $\log_2 M\sqrt{N}$ | 4. $\log_2 \sqrt[3]{M^2 N}$ |
| 5. $\log_2 \frac{M^4}{N^3}$ | 6. $\log_2 \left(\frac{M}{N}\right)^7$ | 7. $\log_2 \sqrt{\frac{M}{N^3}}$ | 8. $\log_2 \frac{1}{MN}$ |

If $\log_{10} 9 = 0.95$ and $\log_{10} 2 = 0.30$ (accurate to two decimal places), find the following.

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|-----------------------------|--------------------------------|---------------------------------------|---------------------|
| 9. $\log_{10} 81$ | 10. $\log_{10} \frac{9}{2}$ | 11. $\log_{10} \sqrt{2}$ | 12. $\log_{10} 3$ |
| 13. $\log_{10} 8$ | 14. $\log_{10} 36$ | 15. $\log_{10} \frac{20}{9}$ | 16. $\log_{10} 900$ |
| 17. $\log_{10} \frac{1}{9}$ | 18. $\log_{10} \frac{1}{2000}$ | 19. $\log_{10} \sqrt[3]{\frac{2}{9}}$ | 20. $\log_{10} 162$ |

Express as a logarithm of a single number or expression.

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|---|---------------------------------------|
| 21. $5 \log_4 p + \log_4 q$ | 22. $\log_{10} x - 4 \log_{10} y$ |
| 23. $4 \log_3 A - \frac{1}{2} \log_3 B$ | 24. $\log_5 M + \frac{1}{4} \log_5 N$ |
- B**
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|-------------------------------|-------------------------------|
| 25. $\log_2 M + \log_2 N + 3$ | 26. $\log_5 x - \log_5 y + 2$ |
| 27. $1 - 3 \log_5 x$ | 28. $\frac{1 + \log_9 x}{2}$ |

Simplify.

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|-----------------------------------|-----------------------------|
| 29. $2 \log_{10} 5 + \log_{10} 4$ | 30. $2 \log_3 6 - \log_3 4$ |
| 31. $\log_4 40 - \log_4 5$ | 32. $\log_4 3 - \log_4 48$ |